PATENT SPECIFICATION 1,116,811

DRAWINGS ATTACHED.

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1,116,811

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Int. Cl.:—G 21 c 3/34.

COMPLETE SPECIFICATION.

Improvements in or relating to Nuclear Reactor Fuel Assemblies.

We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to nuclear reactor fuel assemblies, and in particular to spacer grids for employment in such fuel assemblies and serving for locating and spacing clusters of parallel fuel rods included in the assemblies.

In general, known spacer grids fall into three categories: firstly those made by perforating a plate or disc of material compatible with the sheathing of the fuel rods, secondly grids prefabricated from short tubes or ferrules intended to embrace a portion of the periphery of the fuel rods, with ribs joining the tubes or ferrules into a desired configuration, and thirdly grids made from lengths of strip material bent and secured together so that the strips are edge-on to coolant flow and so as to provide a plurality of cells some or all of which are intended to embrace a portion of the periphery of the fuel rods. It is the last-named category of spacer grids with which the present invention is concerned.

According to the invention, in or for a nuclear reactor fuel assembly which includes a cluster of spaced parallel fuel rods, a spacer grid has a plurality of identical cells of octagonal shape and fabricated from strip material, alternate sides of each cell being secured to registering sides of adjacent cells so as to build up a complete cell structure, the outer sides of the outer cells of such structure being secured to a surround defining the boundary of the spacer grid, and those sides of each cell which are not secured to registering sides of adjacent cells or to the surround having inward projections for contacting and locating a cylindrical fuel rod when embraced by the respective cell.

The said inward projections may be provided by dimpling the non-secured sides of each said cell, or may be provided by stamping out tongues from the non-secured sides of each said cell, the said tongues functioning as leaf springs.

The securing together of registering sides of adjacent cells and of sides of outer cells to said surround is preferably performed by spot-welding, but brazing may be employed as an alternative.

The said surround may be a strip provided with outward projections for locating the spacer grid in a casing of the fuel assembly. Preferably these outward projections are provided by dimpling at points intermediate the positions where the outer cells are secured to the surround strip. Alternatively, the outward projections may be provided by stamped-out tongues as aforesaid.

The configuration of the spacer grid cells lends itself readily to the building-up of grids with either rectangular (e.g. square) or octagonal boundaries which can be employed with fuel element assemblies having casings of corresponding shape. It is obvious that fuel element assemblies with casings of square shape lend themselves readily to being assembled into a core for boiling or pressurised water reactors. Fuel assemblies with casings of octagonal shape, particularly if alternate sides are shorter than the remainder, can also be assembled into a reactor core but will leave quadrilateral section channels which can be employed for control rods, etc.

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A spacer grid according to the invention has its octagonal cells separated by quadrilateral section cells (which are of square section if the shape of each fuel rod-locating cell is regular octagonal), and some of such quadrilateral section cells may be employed for longitudinal solid control members of suitable section where the fuel assemblies are employed in a nuclear reactor which utilises this control principle.

In order that the invention may be fully understood and more readily carried into practice, two constructional examples embodying the invention will now be described with reference to the accompanying drawings, wherein:—

Figure 1 is a plan view of a spacer grid of a nuclear reactor fuel assembly and illustrates one construction,

Figure 2 is an end view in section on line II—II of Figure 1, and

Figure 3 is a similar view to that of Figure 1 and illustrates a second construction.

Referring to Figures 1 and 2 of the drawings, in the construction of fuel assembly spacer grid shown therein, the grid 1 is fabricated from a plurality of identical cells 2 of regular octagonal form and constructed from strip of a suitable material, for example stainless steel. Alternate sides 3 of each cell 2 are secured to registering sides 3 of adjacent cells 2 so as to form a structure such as that illustrated in Figure 1. The securing can be effected by spot welding or by brazing. The remaining sides 4 of each cell 2 are each provided with an inward projection 8 for engaging with and locating a fuel rod accomodated in the cell. Typical fuel rods 5 are illustrated in Figure 2 and are formed from a stack of fissile (e.g. UO_2) pellets 6 enclosed in a protective sheath 7 (e.g. of a zirconium base alloy or a stainless steel). The inward projections 8 of the sides 4 of each cell 2 may as shown in Figure 1 be constituted by dimpling the material of the strip at the centre of each side, or alternatively (not shown) may be provided by stamping out a tongue from the material of each side 4 so as to serve as a leaf spring and effect resilient location of the respective fuel rod.

The example illustrated in Figures 1 and 2 is of a spacer grid suitable for a square-section fuel assembly. The boundary of the grid 1 is provided by a surrounding strip 9 secured to each outer side 3 of each outer cell 2 by either spot welding or brazing. The surrounding strip 9 is provided with outward projection 10 disposed away from positions at which the strip 9 is secured to the sides 3 of the outer cells. The outward projections 10 may be constituted by dimpling, as shown, or by stamped-out tongues (not shown) as aforesaid. The outward projections 10 serve to locate the support grid 1 in a casing 11 forming part of the fuel assembly.

In the example shown in Figures 1 and 2, several spacer grids 1 are intended to be fabricated into a sub-assembly together with fuel rods, the sub-assembly being supported at the bottom of the fuel assembly and able to expand and contract with temperature change, independently of the casing 11. This is effected by employing the four 'corner' fuel rods as structural members connecting the several spacer grids together. The corner fuel rods however are made up from rod sections corresponding in length to the longitudinal spacing between spacer grids. Referring mainly to Figure 2, each corner fuel rod section terminates above a spacer grid with an end cap 12 formed with a screw-threaded spigot 13 engaging a screw-threaded central aperture 14 in an end cap 15 of the fuel rod section below the spacer grid. The end cap 15 has a recess 16 in which is accommodated the arcuate portions of a corner cell 17 of the grid 1, the cell being of generally cruciform section and being secured by either spot welding or brazing on two adjacent sides to sides 3 of adjacent octagonal cells 2 and on the remaining two sides to the surrounding strip 9. There is a shim 18 provided between abutting faces of the end caps 12 and 15 and also serving to retain the arcuate portions of cell 17 in recess 16, and a locking pin 19 serves to prevent unscrewing of the spigot 13 from the aperture 14, there being access apertures 20, 21 in the surrounding strip 9 and registering portion of the cell 17, respectively. Thus the sections of the corner fuel rods are connected to one another and to the respective spacer grid. The remaining fuel rods in the assembly, being of full length, extend through the spacer grids without being axially secured thereto.

Referring now to Figure 3 (in which like parts are indicated by like reference numerals), which illustrates another construction of spacer grid, the grid is similar to that shown in Figures 1 and 2 but instead of having a square boundary has an octagonal one with alternate sides approximately twice as long as the remaining sides. This is accomplished by leaving out the corner cells and incorporating suitably shaped strip members 22 which are secured to two of the outer cells 2^1 as well as to the octagonal surrounding strip 24. An octagonal casing 25 is provided in which the surrounding strip 24 fits with clearance; the strip 24 has outward projections 10^1 which serve to locate the grid in the casing 25. The shape of the casing 25 lends itself to be incorporated with other similar fuel assemblies to form a core structure having

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longitudinal channels in at least some of which can be accommodated solid neutron absorber for control purposes. It will be obvious that the construction can readily be varied to make the boundary of regular octagonal shape (i.e. with eight equal sides).

In both the hereinbefore described constructions, the spacer grids may be longitudinally located relative to the respective fuel assembly casing by securing each grid directly to the casing. Where this expedient is adopted, all the fuel rods may be made of full assembly length and all are axially movable in the respective cells of the grids so as to accommodate differential expansion and contraction between fuel rods and casing on thermal cycling.

It will be observed that spacer grids according to the invention are advantageous in that the inward projections serving to locate the fuel rods are provided in strip material of single thickness, that outward projections of the grids for locating them in a fuel assembly casing are similarly provided in strip material of single thickness, and that the configuration of cells allows a high concentration of fuel rods within each fuel assembly whilst providing ample voidage for coolant.

WHAT WE CLAIM IS:—

1. In or for a nuclear reactor fuel assembly which includes a cluster of spaced parallel fuel rods, a spacer grid having a plurality of identical cells of octagonal shape and fabricated from strip material, alternate sides of each cell being secured to registering sides of adjacent cells so as to build up a complete cell structure, the outer sides of the outer cells of such structure being secured to a surround defining the boundary of the spacer grid, and those sides of each cell which are not secured to registering sides of adjacent cells or to the surround having inward projections for contacting and locating a cylindrical fuel rod when embraced by the respective cell.

2. A spacer grid according to claim 1, wherein the said inward projections are dimples in the material of the non-secured sides of each said cell.

3. A spacer grid according to claim 1, wherein the said inward projections are stamped-out tongues in the material of the non-secured sides of each said cell, the said tongues functioning as leaf springs.

4. A spacer grid according to any of the preceding claims, wherein the securing together of registering sides of adjacent cells and of sides of outer cells to said surround is by spot welding.

5. A spacer grid according to any of claims 1—3, wherein the securing together of registering sides of adjacent cells and of sides of outer cells to said surround is by brazing.

6. A spacer grid according to any of the preceding claims, wherein the said surround is a strip provided with outward projections for locating the spacer grid in a casing of the fuel assembly.

7. A spacer grid according to claim 6, wherein the said outward projections are dimples in the material of the said strip and are provided intermediate the positions where the outer cells are secured to the surround strip.

8. A spacer grid according to claim 6, wherein the said outward projections are stamped-out tongues in the material of the said strip and are provided intermediate the positions where the outer cells are secured to the surround strip.

9. In or for a nuclear reactor fuel assembly, a spacer grid substantially as hereinbefore described with reference to the accompanying drawings.

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Fig. 1.

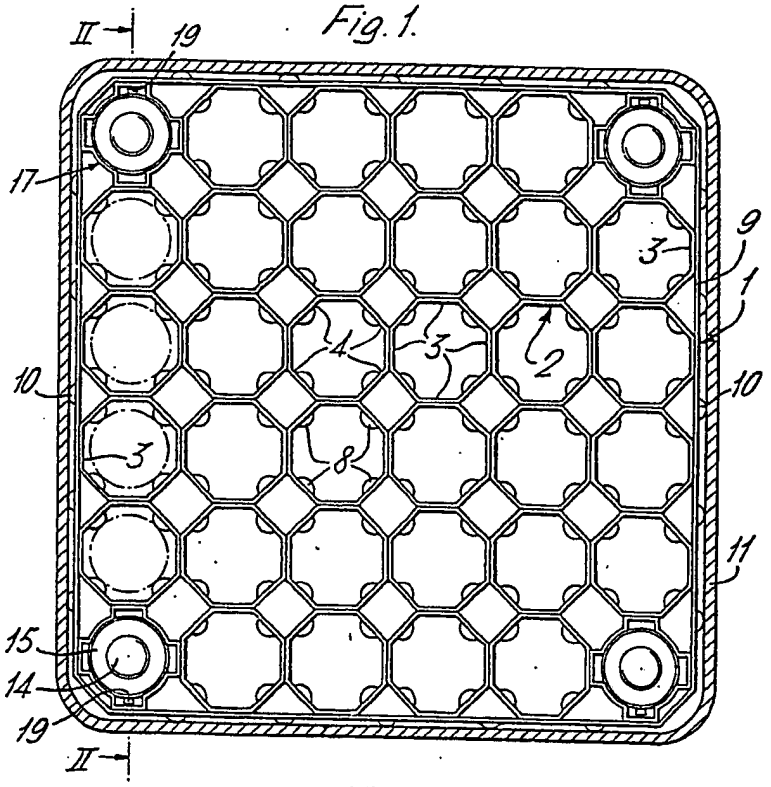
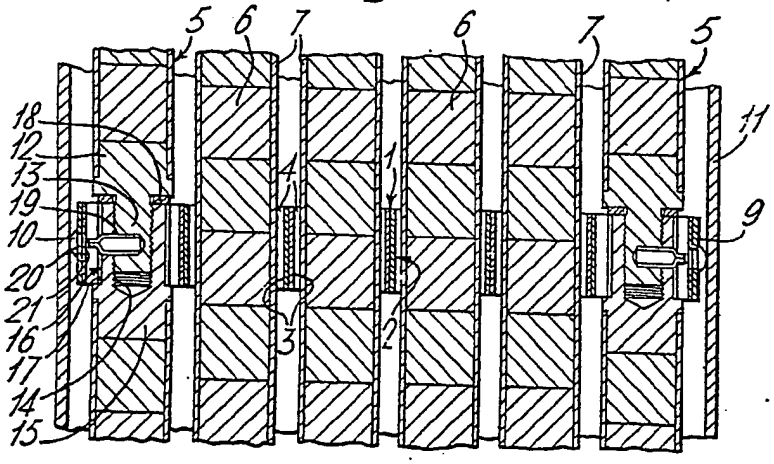


Fig. 2.



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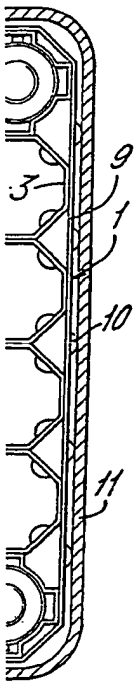
Sheets 1 & 2



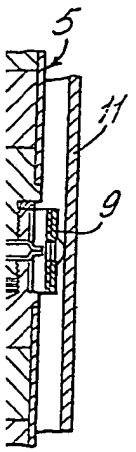
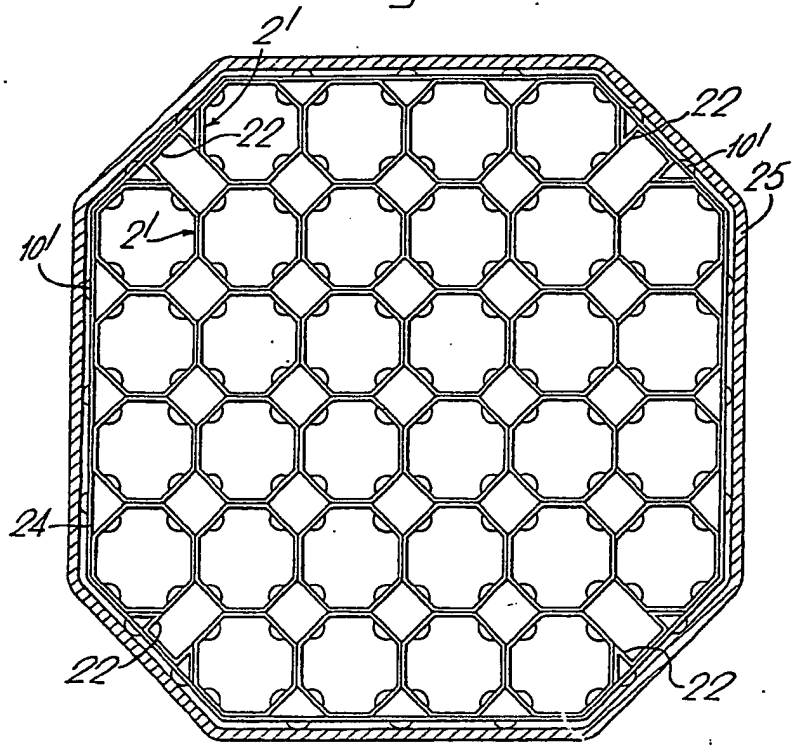


Fig. 3.



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1116811 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

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Fig. 3.

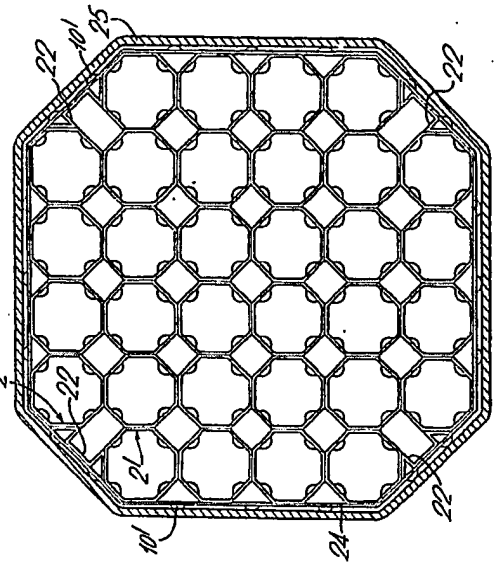


Fig. 1.

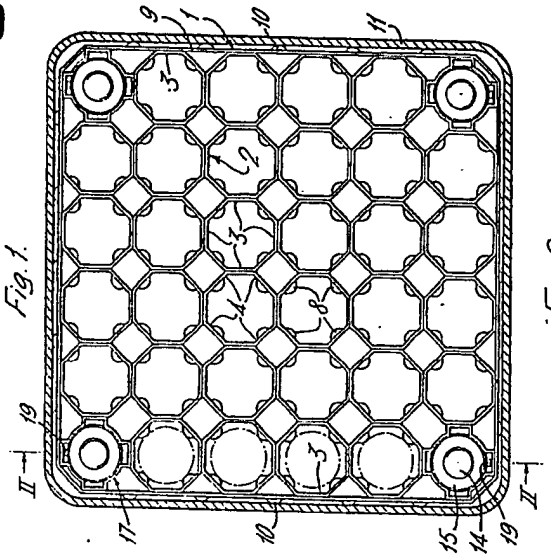
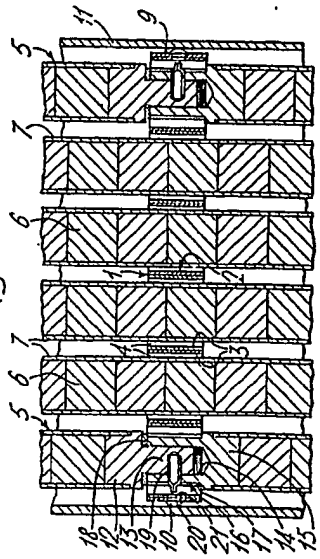


Fig. 2.



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